

known species not only in the ochraceous pubescence but the short, blunt labral process and the sculpturing of the propodeal enclosure.

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Cytology and bionomics of *Primicimex cavernis* Barber¹ (Cimicidae : Hemiptera)

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Primicimex cavernis Barber is considered to be a primitive member of the Cimicidae and exhibits unique characters, such as the absence of a spermalege and the much larger size. The species has been reported only from bat caves in Texas and Guatemala. Practically no biology of this particular species is known, because of rareness and difficulty in keeping specimens alive in the laboratory. Furthermore, the population of Ney Cave in Texas may have been wiped out, since no collection has been made for the last 10 years although several careful surveys were conducted. More knowledge of this particular species is badly needed in order to understand the evolutionary relationships of the Cimicidae. I have been fortunate in finding new localities for the species and have succeeded in maintaining the bugs in the laboratory.

The purpose of this paper is to report some biological and cytological information concerning this unique species.

The author wishes to express his grateful appreciation to Dr. R. L. Usinger (Division of Entomology, University of California, Berkeley) for his help in many ways. Also the author is indebted to Dr. P. Leitner (St. Mary's College) for regularly providing me with host bats for laboratory rearing, and to Mr. J. D. Haddock (Division of Entomology, University of California, Berkeley) for his field assistance.

MATERIALS AND METHODS

The bugs used in this study were collected in the Cave of Janitzio Island, Mexico, and were maintained in the laboratory on *Tadarida brasiliensis mexicana* (Saussure). The laboratory colony has been

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maintained in a cabinet at $27^{\circ}\text{C} \pm 2$ and about 70% relative humidity. Colony members were exposed to room temperature during feeding.

For cytological study, testes or ovaries were fixed in Carnoy. All observations were made from squash preparations stained with aceto-carmine. For electrophoresis, adult haemolymph was taken from females and males by micropipet. Polyacrylamide gel electrophoresis was employed.

NEW LOCALITIES

The known distribution of *Primicimex*, prior to this study, consisted only of Ney Cave, Texas, and Chocoyos, Chimaltenango, Guatemala. The bugs may have been exterminated from Ney Cave by an unknown agency (Usinger, 1966). Recently Mr. Haddock and I made a special trip to Guatemala and Mexico to collect live *Primicimex*. At Chocoyos, Guatemala, although we found the exact cave where the bugs had been collected, we failed to find the bugs. There were neither dead bugs nor skins. However, the following new locations in Mexico were added to the distribution of *Primicimex*:

1. Valladolid Cave, Yucatan, Mexico; 21 March 1967, by J. D. Haddock and N. Ueshima.

We collected complete cast skins and dead adults of *Primicimex* from this locality. The bats were roosting in a fissure of an overhanging cliff outside the main entrance of the cave. Dead specimens and skins were collected at the base of this cliff. We were unable to reach the roosting site itself, since the cliff extended over a deep pool and the face of the cliff was sheer. However, we assume that there is a population of the bugs around the bat roosting site in the cave. We are certain that some of the bats at this locality were *Tadarida brasiliensis mexicana*, because of a unique odor.

2. Cave, Janitzio Island, Patzcuaro Lake, Patzcuaro, Michoacan, Mexico; 23 March 1967, by J. D. Haddock and N. Ueshima. The bug population in the cave was quite dense.²

The cave is located about 500 yds. SE of a statue which stands in the center of the island. The cave consists of a single chamber about 50 ft. deep and 30 ft. high. The opening of the cave is about 10 ft. high and 7 ft. wide. The cave contained thousands of Mexican free-tailed bats, *Tadarida brasiliensis mexicana*. *Primicimex* was easily found and collected on walls, especially in crevices of the walls. All

² Dr. Denny Constantine first noticed "large cimicids" in this cave some years ago and suggested that the cave be searched on the chance that *Primicimex* might be found.



FIG. 1 (left). *Primicimex cavernis* Barber, hiding in a crevice of the wall at the cave, Janitzio Island, Patzcuaro, Michoacan, Mexico. FIG. 2 (right). *Primicimex cavernis* eggs laid on the wall of the cave, Janitzio Island, Patzcuaro, Michoacan, Mexico.

stages of *Primicimex*, from eggs to adults, were readily collected (figs. 1 and 2).

HOST SPECIFICITY

It has been considered that the host of *Primicimex* is the Mexican free-tailed bat, *Tadarida brasiliensis mexicana*. In order to prove this host relationship, an experiment was conducted in the laboratory. Starved adult and nymphal bugs from Janitzio Island were used for the test with the following potential hosts provided for the bugs.

Bat: *Myotis yumanensis* (H. Allen)
Antrozous pallidus (LeConte)
Tadarida brasiliensis mexicana (Saussure)
Rabbit
White mouse
Chicken

In the experiment, the bugs never attempted to feed on any of these animals, except *Tadarida brasiliensis mexicana*. This indicates that the bugs are host specific to the Mexican free-tailed bat.

The bat has a strong and unique odor. This odor may play a part in attracting the bugs. Even when *Antrozous* or *Myotis* were presented to the bugs together with *Tadarida*, the bugs always attempted to feed on *Tadarida* and never on *Antrozous* or *Myotis*.

FEEDING BEHAVIOR

Generally cimicids in the laboratory feed readily on the host through nylon net (see Usinger, 1966, for feeding methods); *Primicimex*, how-

ever, requires direct contact with the host. This difference may be due to the larger size and difference in feeding behavior. The feeding behavior of *Primicimex* is rather unusual in comparison to other cimicids. The feeding behavior of other species of cimicids was described by Usinger (1966). Ryckman (1956) briefly observed the feeding of *Primicimex* at Ney Cave, Texas. The following are some details of the feeding of the bugs observed by me in the laboratory.

The bug approaches its host with its antennae outstretched. When the bug comes within about $\frac{3}{4}$ inch of the host, it momentarily stops moving toward the host, and raises and points its beak toward the host. Immediately after this, the bug jumps onto the host, so that the tip of the beak taps the surface of the bat's wing and tail membranes. Then the bug jumps back about $\frac{3}{4}$ inch and quickly lunges toward the host again. This activity seems to test for prospective feeding surfaces. Such activities are repeated several times until the bat shows no twitching. If on the first trial of tapping the host the bug hits an unsuitable place, it moves away and starts again to approach from a different direction. After a suitable feeding surface is found, the forelegs of the bug are brought into action to grasp the membrane of the host and the beak is introduced into the membrane and blood is sucked in. The bug grasps the host with considerable force and continues the feeding even if the host moves or the experimenter disturbs the situation. During feeding the mid- and hindlegs are almost free from the host. The feeding time to engorgement is 10–15 minutes for 1st instar nymphs and 30–90 minutes for adults.

Occasionally, the bug approaches and probes the lips of the bat. When this happens, the lips twitch strongly. However, the bat does not reject or bite the probing bug. After being probed several times on the lips by the bug, the bat ceases to respond. The bug then feeds on the lip without disturbance. However, when the bat was probed lightly on the lips with a fine needle, the bat reacted immediately by biting the needle.

After engorgement, the bug withdraws its beak from the host, releases the grip by its forelegs and leaves the host.

LIFE HISTORY

Fifty-four eggs were placed individually into small vials. The same vial was used to hold each bug from egg to adult. Since, as described previously, *Primicimex* requires direct contact with the host, each specimen was taken out of the vial during feeding. The bug was allowed to feed on the host once every ten days. The average size of

TABLE 1. Summary of life history of *Primicimex* in days.

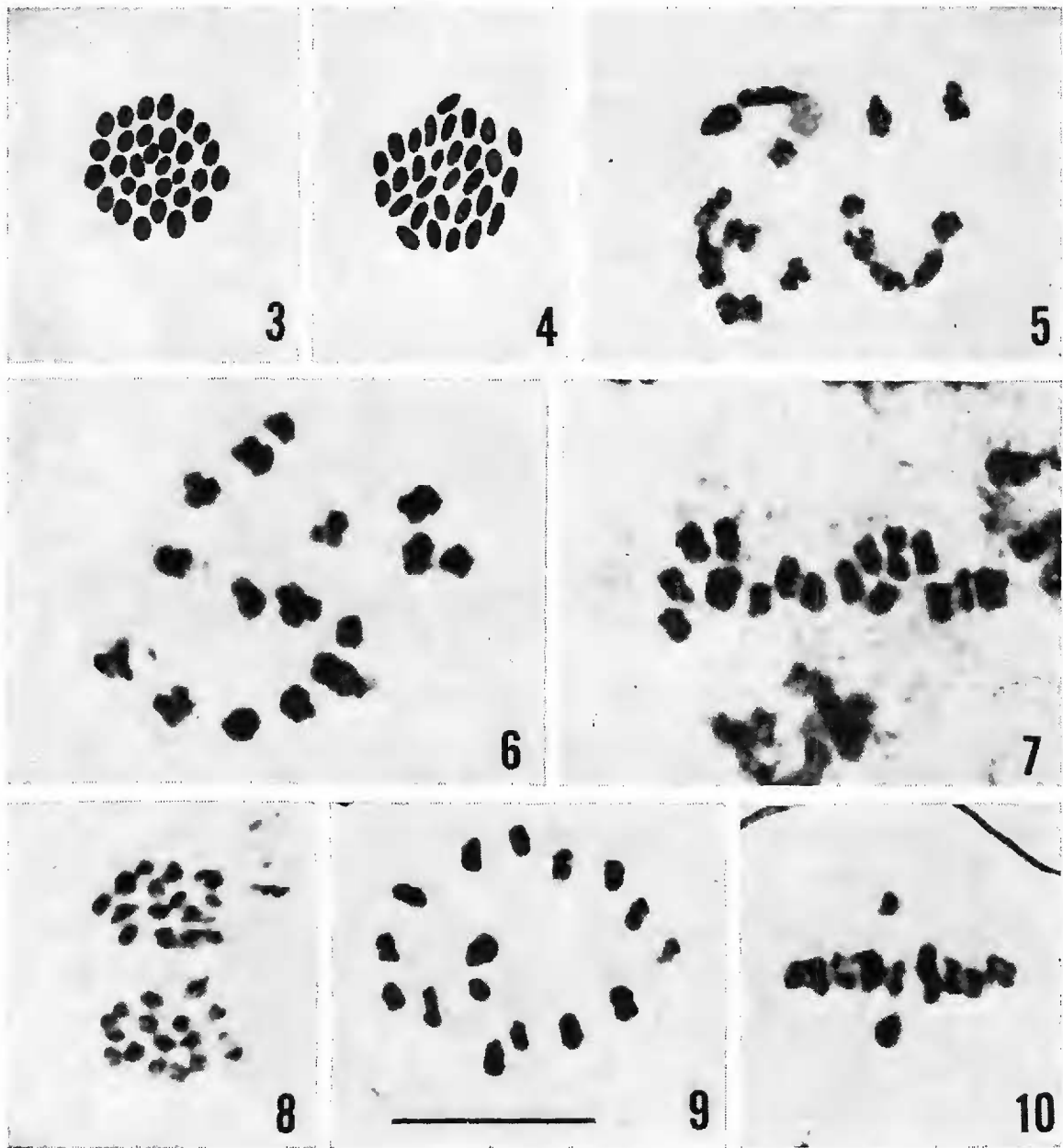
Stage	Female		Male	
	Duration	Average	Duration	Average
Egg	13-17	15.2	13-18	15.4
1st instar	9-41	18.2	10-30	15.4
2nd instar	9-24	12.1	9-27	15.0
3rd instar	10-26	13.9	9-26	16.2
4th instar	12-36	22.9	12-36	18.5
5th instar	16-33	21.9	16-45	25.8
1st to adult	70-115	89.1	72-117	91.5
egg to adult	83-132	104.3	85-135	106.9

egg was 2.5 mm in length and 1.05 mm at maximum width and 0.5 mm at the egg cap.

The eggs used were known to have been 24 hrs. old or less and eggs or nymphs were checked for hatching or moulting every day after the eggs were placed in the vials.

All 54 eggs hatched. The average time to hatching was 15.3 days with 13 days minimum and 18 days maximum. The average number of days required to become adult was 104.3 days for the females and 106.9 days for the males. The longest instar was the 4th for females and the 5th for males. Out of 54 eggs hatched, 24 died during development, mostly in the 1st and 2nd instars, and 30 became adults. Out of 30 adults, 13 were females and 17 were males. The sex ratio of males to females was 56.7 : 43.3, this ratio, of course, would change if a large number were scored. The summary of the life history of *Primicimex* is shown in Table 1.

The life history of *Primicimex* is rather longer than the other species of cimicids. Under our rearing conditions ($72^{\circ}\text{C} \pm 2$ and about 70% R. H.), most species of cimicids so far studied develop at the rate of about one generation per month. Also Omori (1941) reported that the duration of the life cycle at 27°C was 31.3 days for *Cimex lectularius* Linn., and 30.8 days for *C. hemipterus* (Fabr.). The duration of the life cycle for *Hesperocimex sonorensis* Ryckman was 40.1 days at 27°C (Ryckman, 1958) and for *Haematosiphon inodorus* (Duges) 37.1 days at $25-29^{\circ}\text{C}$ (Lee, 1955). However, the life history for *Bucimex chilensis* Usinger, which is considered the most closely related species to *Primicimex*, was 123.2 days at 28°C (Usinger, 1966). These two genera are strikingly larger in size than other cimicids. Thus, the



FIGS. 3-10. Meiosis of *Primicimex cavernis*. Magnification is indicated by 10- μ scale. FIG. 3. Spermatogonial metaphase with 30 chromosomes. FIG. 4. Female somatic metaphase with 30 chromosomes. FIGS. 5-10. Male meiosis. FIG. 5. Early diakinesis, the X and Y are associated with nucleolar organizer. FIG. 6. Diakinesis with 16 chromosome entities. FIG. 7. First metaphase. FIG. 8. First telophase. FIG. 9. Second metaphase, the X and Y are located in the center of a hollow spindle formed by autosomes. FIG. 10. Second metaphase, side view. The X and Y are preceding.

longer life history of these two genera may be due to the difference in body size.

CYTOLOGY

The chromosome number of *Primicimex* was briefly observed by Ueshima (1966) from Ney Cave material preserved in alcohol for several years and, therefore, not fixed properly. Using fresh specimens

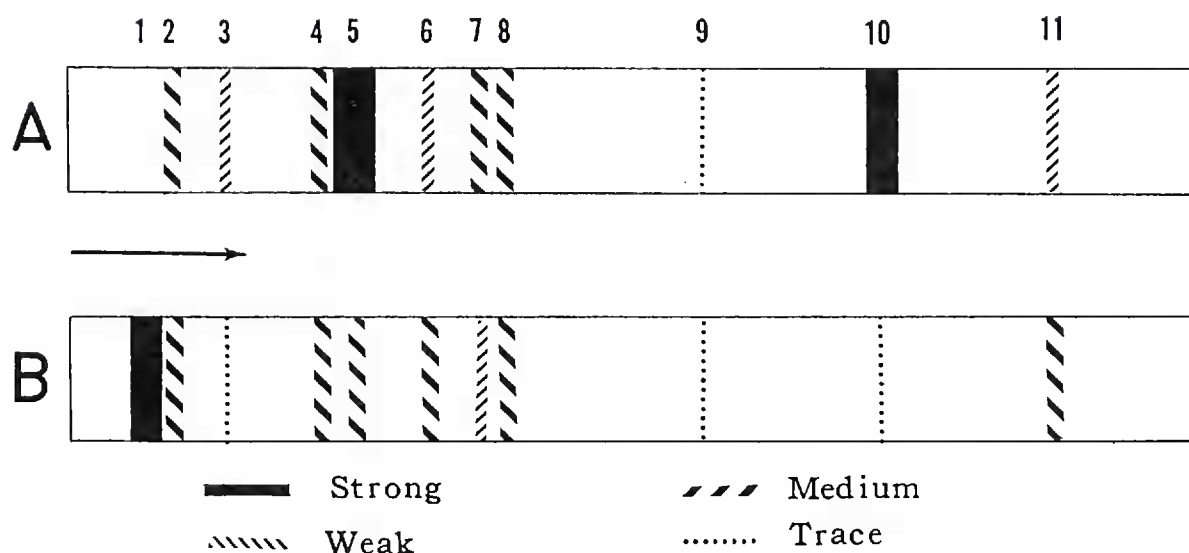


FIG. 11. Haemolymph protein patterns of *Primicimex cavernis*. A, female; B, male.

from Janitzio Island, additional observations were made showing that the previous results were inaccurate.

The diploid chromosome complement of the species is $28 + XY$ in the male and $28 + XX$ in the female (not $8 + XY$ and $8 + XX$ as previously reported) (figs. 3 and 4). All chromosomes are very much alike in size.

As is usually the case in the cimicids (Ueshima, 1963, 1966 and 1967), it was not possible to analyze the details of early prophase of meiosis. At the diffuse stage, there are two heteropycnotic elements, the X and Y. In diakinesis the chromosomes become evident, the two members of each bivalent lie parallel, and bivalents usually each have one chiasma. In diakinesis there are 16 chromosome entities (figs. 5 and 6).

As the first metaphase is formed, 14 autosomal tetrads and the X and Y dyads arrange themselves on the equatorial plate (fig. 7). The sex chromosomes are usually distinguished from the autosomes because they are composed of two chromatids instead of four as in autosomes. The first division is reductional for the autosomes and equational for the sex chromosomes (fig. 8).

At the second metaphase which directly follows the first without any resting stage, 14 autosomes form a hollow spindle, while the X and Y always lie in the center of the hollow spindle (fig. 9). At the second division, the X goes to one pole with autosome halves and the Y moves to the other pole (fig. 10).

The nearly related *Bucimex chilensis* Usinger has $26 + XY$ in the male and $26 + XX$ in the female (Ueshima, 1966).

ELECTROPHORESIS

Figure 11 shows haemolymph protein patterns of the female (A) and male (B) *Primicimex*. The proteins are numbered according to their mobilities. The degree of intensity of the fractions is recorded under 4 categories: strong, medium, weak, and trace.

As seen in Figure 11, the protein patterns of the female and male are strikingly different. The female shows 10 fractions, while the male exhibits 11. The female lacks fraction 1. Fraction 10 is strong in the female and medium in the male. Also, there are some differences in fractions 3, 6, 7, and 11 between the male and female protein patterns. The most significant differences in protein patterns between the male and female are fractions 1, 5, and 10.

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